1984 NOVA

Breakthrough Laser Science and Technology

In the early 1980s, researchers were exploring how to produce x-ray laser beams initiated by nuclear explosives at the Nevada Test Site. At the same time, success was achieved creating a soft-x-ray (about 200 angstroms) laser in a laboratory setting using the Novette laser, which was a test bed for the design of Nova. Nova became operational in December 1984, enabling further groundbreaking research in x-ray lasers and many other areas of laser science and technology.

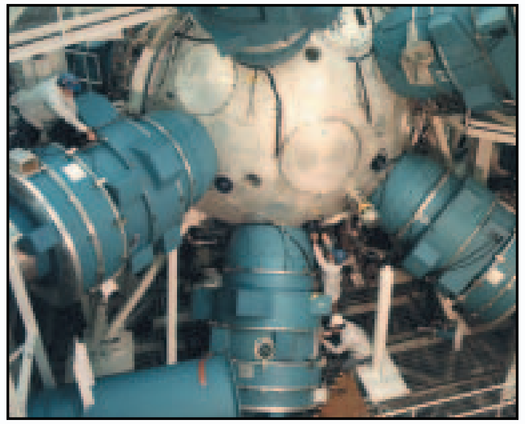
Ten times more powerful than Shiva, its predecessor, Nova was the world's most powerful laser. Its 10 beams produced laser pulses that delivered up to 100 trillion watts of infrared laser power for a billionth of a second. For that brief instant, its power was over 25 times greater than the combined power produced by all the electrical generating plants in the United States.

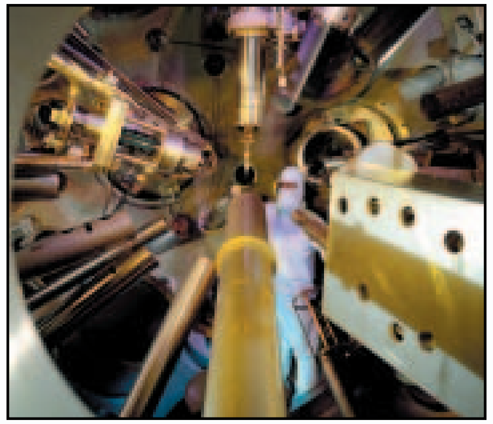
In 1986, in inertial confinement fusion experiments, Nova produced the largest laser fusion yield to date—a record 11 trillion fusion neutrons. The following year, Nova compressed a fusion fuel pellet to about 1/30th its original diameter, very close to that needed for high gain (fusion energy exceeding energy input). The laser exceeded its maximum performance specifications in 1989 when Nova generated more than 120 kilojoules of laser energy at its fundamental infrared wavelength in a 2.5-nanosecond pulse. In addition, in 1996, one arm of Nova was reconfigured as a petawatt laser. Record-setting laser shots produced pulses with more than 1300 trillion watts, or 1.3 petawatts, of peak power. The laser pulse lasted less than one-half trillionth of a second—more than a thousand times shorter than shots typically produced by Nova's 10 beams.

About 30 percent of Nova's shots were used by the nuclear weapons program. When the United States ceased nuclear testing, laser facilities became even more important for defense research, and the portion of Nova shots dedicated to the weapons program increased considerably. Researchers using Nova continued obtaining high-temperature data necessary to validate the computer codes used to model nuclear weapons physics.

Livermore also developed increasingly sophisticated diagnostic instruments to measure and observe what was happening with the laser beam, in the target, in the interaction between the laser light and the plasma, and in the fusion process. Some of the technologies provided spin-off advances, such as improved medical technologies, femtosecond laser machining, and techniques for using extreme ultraviolet light for lithography to produce faster computer chips (see Year 1999).

Nova served as the proving ground for the 192-beam National Ignition Facility (NIF). Achievements on Nova helped scientists to convince the Department of Energy of the viability and probable ultimate success of achieving thermonuclear ignition on NIF (see Year 1997).





In 1984, when it began operation, Nova was the world's most powerful laser. Laser pulses were produced with 10 beams (top), which were directed to a 5-meter-diameter target chamber (far left). Inside the chamber (left), the laser light was focused on BB-size targets.

Nova Shutdown

An era ended at the Laboratory in May 1999 when Nova fired its last shot. After 14 years and more than 14,000 experiments, Nova sent its last 10 beams of light down its 280-meter tubes in an experiment for the Stockpile Stewardship Program.

"It was very much a bittersweet moment," said Kim Budil, Laser Programs physicist and lead experimenter on the final shot. "The excitement of the shot was dampened by the realization that this was absolutely the last experiment we would ever perform with Nova."

"Nova has been an extremely successful facility," said John Emmett, associate director for Laser Programs when Nova was designed and built. "It's been a lot more productive than anyone thought it would be."

Nova was dismantled and some parts were shipped to other research facilities for their laser fusion and science programs.